WORKPIECE IN MOVEABLE EQUIPMENT, issued to Bruning on November 15, 1988, based upon an application 60,876, filed on June 12, 1987 ("Bruning").

Bruning discloses:

A deep-UV step-and-repeat photolithography system includes a narrow-bandwidth pulsed excimer laser illumination source and an all-fused-silica lens assembly. The system is capable of line definition at the 0.5-micrometer level. One significant feature of the system is its ability to perform wafer focus tracking by simply changing the frequency of the laser. (Abstract)

Establishing the cneter [sic] wavelength of the laser output 55 at a predetermined value and thereafter precisely maintaining the wavelength at that value (or purposely moving the wavelength off that value to accomplish electronic focus tracking) can be done in a variety of ways. Illustratively, this is accomplished by rotating any one or combination of the elements 48, 50 and 52 about an axis perpendicular to the plane of the paper on which FIG. 3 is drawn. For coarse tuning, rotating the mirror 52 and/or the grating 50 is satisfactory. For fine tuning, rotating only the etalon 48 is effective. In practice, it is usually advantageous to initially establish the predetermined center wavelength by rotating one or both of the elements 50 and 52. Thereafter, the laser can be maintained at that wavelength or fine-tuned therefrom by selectively controlling the orientation of only the etalon 48.

As schematically indicated in FIG. 3, a micropositioner 56 is connected via a mechanical coupler 58 to the etalon 48. In response to signals applied to the micropositioner 56 on line 60, the orientation of the etalon is thereby controlled to maintain the wavelength of the laser beam 55 at a predetermined value or to move the wavelength off that value by a specified amount to accomplish electronic f cus tracking. The manner in which the micropositioner 56 is so controlled will be described in detail later bel w.

Various instrumentalities are known in the art for tuning and line-narrowing the output of a short-wavelength laser in the general manner carried out by the aforespecified assembly 54. In this connection, see, for example: "Injection-Locked, Narrow-Band KrF Discharge Laser Using an Unstable Resonator Cavity" by J. Goldhar et al, Optics Letters, Vol. 1, No. 6, December 1977, pp. 199-201; "Operating and Beam Characteristics, Including Spectral Narrowing, of a TEA Rare-Gas Halide Excimer Laser" by T. J. McKee et al, IEEE Journal of Quantum Electronics, Vol. QE-15, No. 5, May 1979, pp. 332-334; "Grazing Angle Tuner for CW Lasers" by K. R. German, Applied Optics, Vol. 20, No. 18, September 15, 1981, pp. 3168-3171; and "A Simple Tunable KrF Laser System with Narrow Bandwidth and Diffraction-Limited Divergence" by R. G. Caro et al, Journal Physics D: Applied Physics, 15, 1982, pp. 767-773.

The aforedescribed feedback loops for controlling the galvanometer motors 30 and 32 (FIG. 1) require continuous electrical signals therein. But the pulsed laser 12 is not capable of providing such signals via the detector 24 (FIG. 2). Hence, a continuous-wave (CW) laser 62 (for example, a standard helium-neon laser operating at 6328 Å is also included in the equipment 10. The laser 62 is designed to provide a continuous reference beam that is coaxial with the aforespecified beam at 2484 Å. In turn, the beam at 6328 Å is converted by the detector 24 into continuous electrical signals that are applied to the feedback loops that respectively control the galvanometer motors 30 and 32.

Whenever the detectors 24 senses that the reference beam at 6328 Å is off-center relative to its prescribed alignment with the detector 24, correction signals are applied to the motor 30 and/or to the motor 32 to re-establish the prescribed alignment. And, since the beams at 6328 Å and 2484 Å are propagated coaxially in the equipment 10, these correction signals are effective to re-establish the prescribed alignment of the exposing beam at 2484 Å. (Col. 5, line 38 - Col. 6, line 36)

In accordance with a feature of the principles of the present invention, the slightly oversize beam directed at the stop 82 is dithered or moved systematically by small amounts ΔX and ΔZ. For an exposure that comprises, for example, several hundred successive laser pulses, such movement is effective in practice to accomplish area averaging of the pulses transmitted throguh [sic] the stop 82. In turn, this results in better illumination uniformity at the surface of the wafer 40.

Movement of the 2484 Å beam directed at the stop 82 (FIG. 2) to carry out area averaging is controlled by the computer 38 (FIG. 1). Signals applied by the computer 38 via leads 86 and 87 to the galvanometer motors 30 and 32, respectively, are effective to implement the aforementioned Δ [sic] and ΔX movements of the beam across the aperture in the stop 82.

The 2484 Å beam that passes through the stop 82 impinges upon a mirror 88 shown in FIG. 2. This mirror is designed to reflect a relatively small amount (for example about one percent) of the incident beam. In turn, the reflected portion is directed through a filter 90 to a photodiode 92. The filter 90 is designed to pass light at 2484 Å but to block light at 6328 Å. In that way, any 6328 Å component in the block transmitted by the stop 82 is prevented from impinging on the photodiode 92.

The photodiode 92 of FIG. 2 constitutes part of a dose control and laser trigger arrangement. The photodiode 92 samples a portion of each 2484 Å pulse and, in response thereto, generates an electrical signal that is applied to a light integrator 94 (FIG. 1). The control computer 38 supplies a second input signal (a dose control signal) to the light integrator 94. In turn, the output of the integrator 94 is applied to the laser 12 as a trigger signal therefore. (Col. 8, lines 1-35)

A typical cycle of operation will illustrate the manner in which the aforementioned dose control and laser trigger arrangement functions. Under

computer control, the stepping table 16 is moved by a micropositioner 95 to bring a chip site on the resist coated wafer 40 into position for exposure to the pattern contained on the reticle 84. (Illustratively, the reticle is assumed to contain a single chip pattern thereon.) The computer 38 then activates the integrator 94 to trigger the laser 12 to start emitting pulses at 2848 Å. A portion of each pulse is sampled by the photodiode 92 and a signal representative thereof is applied to the integrator 94. When the integrator 94 detects that the prescribed dose set by the computer 38 has been attained, the laser 12 is signaled to cease emitting pulses. Subsequently, the table 16 is moved to position another chip site on the wafer 40 in position for the next exposure.

In addition Bruning discloses:

In accordance with the principles of the present invention, focus tracking is carried out quickly in an advantageous nonmechanical manner. The ability to do so stems from the fact that applicant's equipment includes lenses made from a single optical material. Such lenses, unlike those corrected for chromatic aberrations, exhibit an approximately linear relationship between wavelength and focal distance. Hence, by electronically changing the wavelength of the laser 12 (FIG. 1), the focal plane of the projection lens 108 (FIG. 2) is also changed.

The mode of operation of applicant's unique focus tracking arrangement is as follows. First, a standard focus sensor 111 detects whether or not the distance between the projection lens 108 and the surface of the wafer 40 has changed from a prespecified value. Assume, for example, that that distance has changed (decreased) by one micron, due, for example, to warpage in the wafer 40. A signal representative of the change is then sent to the computer 38 via lead 122. In response thereto, the computer applies a corresponding correction signal to the differential amplifier 72 (FIG. 1) included in the afore-described frequency control loop. In turn, a signal is applied by the amplifier 72 to the tuning and line-narrowing assembly 54 to increase the center wavelength of the pulses emanating

from the assembly 54. In one specific illustrative case, the center wavelength was increased by 0.1 Å. This was sufficient to decrease the focal distance of the lens 108 by one micron, thereby to compensate exactly for the assumed one-micron decrease in the lens-to-wafer spacing. (Col. 10, lines 7-45)

The present invention relates in part to:

Dither Tuning Mirror To Simulate Desired Wavelength

The wavelength and bandwidth monitoring equipment and the wavelength tuning equipment described in detail below permit bandwidth control of the laser beam. In a first embodiment the tuning mirror is dithered at a desired frequency and amplitude to basically widen a too narrow bandwidth to an effective bandwidth having a desired value.

The technique involves monitoring the bandwidth with wavemeter 104 shown in FIG. 5 and FIG. 6. If the bandwidth is less than the desired bandwidth the wavelength control equipment is utilized to dither mirror 14 shown in FIG. 5 at frequent intervals to cause very slight shifts in the spectrum on a pulse to pulse basis so that the average integrated spectrum over a window of pulses simulates approximately a constant spectrum with bandwidth approximating the desired bandwidth.

For example, if the optical equipment for a scanner is designed for a bandwidth of 0.4 pm and because of a decrease in the fluorine concentration the bandwidth of individual pulses is 0.3 pm, mirror 14 may be dithered about its nominal position to produce plus and minus shifts in the nominal wavelength of about 0.05 pm in order to maintain the same nominal wavelength with the effective increase by 0.1 pm. For a typical commercial excimer laser of the type discussed above, a change in the pivot position of mirror 14 of about 2 nm is required to produce a 0.05 pm shift in the wavelength. This change in mirror

position is easily provided by the piezoelectric drivers referred to above and shown in FIG. 5A as item 80. Typically in the integrated circuit fabrication each spot on the wafer is illuminated with a number of pulses usually in the range of about 30 to 150 pulses so that the dither rate should be sufficient so that each die spot receives about equal portions of pulses from both sides of the dither. (p. 8)

It is apparent from the above that Bruning discloses a stepper-scanner lithography system with computer control of the mechanisms within the stepper-scanner lithography system, and not the claimed invention. The only signals from the stepper-scanner of Bruning to the laser are an on-off command and a wavelength change command. The on-off command is based upon a dose of light received at the wafer, delivered by the stepper-scanner and the wavelength change is done in accordance with the distance between a portion of the stepper and the wafer.

It is also apparent from the above that the disclosure of Bruning is lacking at least the following features of the claimed invention as recited in claim 1:

> modeling with a computer program lithographic parameters to determine a desired laser spectrum needed to produce a desired lithographic result ...

and

> utilizing a fast responding tuning mechanism to adjust center wavelength of laser pulses in a burst of pulses to achieve an integrated spectrum for the burst of pulses approximating the desired laser spectrum.

As to claims 4 and 5, Bruning does not disclose: wherein a wavelength spectrum is measured for each pulse (claim 4) and claim 5, which depends from allowable claim 3, should be allowed along with that claim. *In re Fine*, 837 F.2d 1071, 5 U.S.P.Q.2d 1596 (Fed. Cir. 1988)

As to claims 2 and 3, the claims depend from allowable claim 1 and should be allowed along with that claim. *In re Fine*, 837 F.2d 1071, 5 U.S.P.Q.2d 1596 (Fed. Cir. 1988)

Regarding claims 6-8 applicants submit that the Examiner has no support in the record for any inherency of the recitations concerning the desired laser spectrum comprising at least two peaks, which claim 1 recites are made by the laser control system by forming with a burst of pulses an integrated spectrum approximating the desired spectrum.

Such a bald assertion of inherency is not sufficient to support a rejection and the Examiner must have evidence in the record to support this type of assertion. *In re Lee*, 277 F. 3d 1338, 1344, 61 U.S.P.Q. 2d 1430 (Fed. Cir. 2002) (" 'deficiencies of the cited references cannot be remedied by the Board's general conclusions about what is "basic knowledge" or "common sense." ' The Board's findings must extend to all material facts and must be documented on the record, lest the 'haze of so-called expertise' acquire insulation from accountability."). See also, *In re Thrift*, 298 F. 3d 1357, 63 U.S.P.Q. 2d 1357 (Fed. Cir. 2002).

Conclusion

For the foregoing reasons, applicants assert that claims 1-8 are not anticipated by or even taught or suggested by Bruning and respectfully request the Examiner to withdraw the rejection of claims 1-8 for anticipation by Bruning and allow claims 1-8.

No fee is believed due in connection with the filing of this Response, but if any fee is due, the Commissioner is authorized to charge such fee, or credit any overpayment to Deposit Account No. 03-4060.

Respectfully submitted,

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